EVALUATION OF 'PUREAU' WATER FOR USE AS EMERGENCY DRINKING WATER FOR ADF AIRCRAFT

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Evaluation of "Pureau" Water for Use as Emergency Drinking Water for ADF Aircraft

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MRL Technical Note
MRL-TN-648

Abstract

A commercially available, purified water packed in PET bottles has been tested for suitability as an emergency drinking water for ADF aircraft.

The water meets chemical and organoleptic requirements of the ADF, and is preferred to the current product on the basis of taste and the lower permeability of the package to water.

The product failed to meet the ADF's stringent microbiological specifications.

Further testing is required to determine the ability of the package to withstand the forces of ejection, and the high temperatures within the cockpit of aircraft parked in the sun in tropical areas of Australia.

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1. Introduction

The RAAF require a source of potable, long-life water for use in Personal Survival Packs (PSP). These are stored in the ejection seats of high performance aircraft and on other ADF aircraft. The current water is supplied by MRL-Tasmania to RAAF Specification (RAAF, 1973). Scottsdale municipal water is filtered and packed in a PVC bag, constructed from the same material used for blood bags. The final sterilisation of the water is by irradiation, although in the past the bags have been filled hot after sterilisation of the water by boiling, and also by aseptic filling after sterilisation by filtration.

The small quantities required by RAAF, currently 4000 packs per annum, mean that it has been difficult to have the packaging carried out on a commercial basis.

The material used for the bag has disadvantages. Plasticisers added to the plastic migrate into the water during storage giving the water a taint or unpleasant taste. The components migrating into the water are not considered harmful.

PVC has poor gas and water vapour barrier properties. Of most concern for the current application is the ability of water to migrate through the package. It has previously been shown that Emergency Water pouches held in a warm dry environment can lose several grams of water per day by transmission through the plastic. While the loss of water by this method is expected to be much lower under realistic storage conditions, this loss of water is the major limitation leading to the useful shelf life of two years.

RAAF, through HQADF, asked for an evaluation of the shelf life of a commercial product, "Pureau", produced by Noble Beverages. "Pureau" is claimed to be an extremely pure, sterile water packed in a blown PET (polyethylene terephthalate) bottle similar to bottles used for soft drinks.

2. *Methodology*

2.1 *Storage*

Five samples of Pureau were stored at each of 30°C and 37°C, in temperature controlled rooms, further samples were stored at ambient temperature in the laboratory. No attempt was made to control humidity, but due to ambient temperatures being below storage room temperatures, humidity was low. Measurements on one occasion indicated relative humidities of 42% and 26% in 30°C and 37°C rooms respectively. Samples were unwrapped, and stored on open shelves so that there was free circulation of air around each bottle. The air in the room was circulated by integral fans.

All samples were weighed at regular intervals over a fifty-six day period.

2.2 *Microbiological Analysis*

The sterility of five bottles from each of the storage temperatures and water stored at ambient temperature was examined using the pour plate method with Plate Count Agar (PCA) and R2A agar, with incubation at 30° C for five days (APHA, 1985).

2.3 *Organoleptic Assessment*

Samples of water stored at 30°C, 37°C and ambient temperature for 56 days, and at 80°C for fifteen hours were presented in randomised fashion to ten tasters, and ranked for flavour. Scottsdale municipal water was included as a control. Results were analysed by normalisation of the data (Fisher and Yates, 1949) and analysis of variance (Beyer, 1968).

2.4 *Physical Testing*

Bottles were placed in a stirred water bath at 70°C, 75°C, 80°C and 85°C for two hours. They were then examined for distortion or other damage.

Bottles were placed in a vacuum chamber and the pressure reduced to below - 80 kPa gauge. The bottles were observed for signs of leakage or other damage.

3. *Results and Discussion*

3.1 Chemical Analysis

Pureau is a highly purified and sterilised water packed in 350 mL PET bottles. The specifications supplied by Noble Beverages indicate less than 0.1 ppm for a wide range of elements, with most figures listed as less than 0.001 ppm. Figures relate to the level of detection of the particular element, and do not appear to be based on any scientific reasoning for requiring such low levels.

Typical analysis figures were supplied by Noble from Australian Government Analytical Laboratories (AGAL). AGAL is registered under the National Association of Testing Authorities (NATA), although the analysis report did not indicate this.

Further chemical analysis of Pureau was not undertaken.

The levels of dissolved solids are extremely low and equate to distilled, deionised water. Water of such quality is not required for drinking, or for storage under the conditions required by RAAF.

Water with higher concentrations of dissolved solids should be satisfactory for the intended use by RAAF, and could possibly be preferred by taste. While this has not been broached with Noble Beverages, it is unlikely that they would be willing to run such water through their plant, given the small quantities used by RAAF, and their presumed desire not to contaminate their equipment. This could be a subject of future discussion between Noble Beverages, or another manufacturer of bottled water, and RAAF.

3.2 Water Permeation of Packaging Material

Water loss from the bottles averaged 0.037 and 0.057 g per day at 30°C and 37°C respectively, over a 56 day period. The PVC material previously used has been shown to lose up to 2.5 g per day under similar conditions.

The loss of water from the PET bottles is therefore only 2% of that of the PVC pouches. It takes approximately 60 days for 1% of the water to be lost under the most extreme storage conditions studied. This extrapolates to a loss of the order of 10% of contents over a two year period. While water is in the PSP or packaged in the store, there will be no air movement, and possibly some build up of humidity within the closed environment around the bottled water. Because of this higher humidity, even when external conditions of low humidity exist, the loss of water by permeation is likely to be less than in the experimental situation. The shelf life of the bottled water is therefore not limited by the loss of water.

3.3 Microbiological Investigation

Microbiological analysis figures supplied by Noble Beverages, indicate a total microbiological count of less than one colony forming unit per 100 mL of water. Analysis figures were supplied by two independent laboratories, AGAL and Stanford Consulting Laboratories. Neither laboratory indicates on their report if

they have NATA registration for the analysis undertaken. The reports do not claim to have incubated the bottled water prior to analysis.

These analyses indicate only three day incubation of the water samples. Bacteria contaminating stored, bottled water are stressed, and therefore initially grow slowly. It is therefore usual to incubate such samples for at least three days using PCA and five days using R2A medium (APHA, 1985, p.862). Previous testing of irradiated water has also indicated very slow growth for a particular organism found to contaminate this product. Microbiological analysis was therefore conducted on the samples of Pureau. R2A medium is a low nutrient medium designed for the testing of water. The low nutrient level helps prevent stress caused by transfer from the very low level of nutrients present in water to media such as PCA.

As the water had been stored (incubated) for a lengthy period before use, testing was carried out by plating rather than Millipore filtration. The filtration methods are more sensitive, but possibly too sensitive if any multiplication of organisms had occurred during storage.

Of the fifteen bottles analysed, thirteen had total plate counts of less than one organism per millilitre of water. However two bottles stored at 30°C and 37°C, had bacterial counts of 34 and 33 per millilitre respectively on PCA. Counts (39, 39) using R2A were marginally higher.

This level of contamination is within the Australian standard for Total Plate Counts of bottled water of 100 microorganisms per millilitre, using PCA (NH & MRC, 1991), but well outside Nobles specification of less than one microorganism per 100 mL. The bottles showing growth were also outside the RAAF Specification (RAAF, 1973) which calls for less than one microorganism per millilitre.

The organism isolated from the samples has been identified as a *Flavobacterium* spp. The identification was based on the pink pigmentation of the colony on PCA and the biochemical profile using API20NE (API System). *Flavobacteria* are widely distributed in soil, and fresh and marine waters. They are not generally considered pathogenic to humans.

A greater knowledge of the processing and filling technology employed by Nobles is necessary to comment on the possible cause of this minor contamination.

3.4 *Organoleptic Assessment*

Results of the ranking test of Pureau and Scottsdale town water gave rank totals from 25 to 37, based on ten tasters. There were no significant differences between the rank totals for any of the samples tested, including the sample subject to temperature abuse.

3.5 *Physical Characteristics*

One of the claimed advantages for the PVC material, that has been in use for over ten years, was its ability to withstand the forces of ejection. The bag was designed to withstand forces amounting to the weight of the pilot plus equipment being accelerated by the ejection seat. This could amount to 250 kg at 12 *g*, or

3 tonne. These figures are considered excessive, as most of the weight of the pilot is taken by the seat pan of the ejection seat.

No work has been carried out on the forces that this PET container is able to withstand. RAAF will need to carry out simulated ejections at AVMED, to determine the suitability of the container for ejection seat use.

The bottle suffered no damage or leakage when subjected to a pressure of - 80 kPa gauge.

Bottles were heated in a water bath to hasten the extraction of taints from the bottle material. Some bottles were observed to distort, and a study was therefore conducted. At temperatures above 60°C the main part of the bottle shrunk. This is due to the "memory" built into the bottle during the blowing operation. This shrinkage caused expansion in the neck region. At a temperature of 85°C, this distortion was sufficient to cause considerable weakening of the bottle, such that it would not be able to withstand ejection.

Temperature inside aircraft sitting in the open rise considerably above ambient temperature. RAAF need to consider what temperatures are achieved in Australia's tropical north, and whether the PET bottle is suitable for these conditions.

4. Conclusions

a. Pureau bottled water produced by Noble Beverages is chemically suitable for its intended use in ADF aircraft.

b. Pureau meets Australian standards for packaged water and is considered suitable for use in PSP. The failure to meet the manufacturer's specification should be brought to the manufacturer's attention.

c. The shelf life of Pureau, based on water permeation through the bottle wall is well in excess of two years.

5. Recommendations

a. The suitability of the bottle for ejection seat use should be tested by simulated ejection.

b. The suitability of the bottle to withstand temperatures attained within aircraft needs to be ascertained.

c. Other manufacturers of bottled water could be approached to obtain alternative suppliers, and competitive quotes.

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